

Amendments to the Claims:

This listing of claims will replace all prior versions of claims in the application.

Listing of Claims:

1. (previously presented): A composite comprised of at least two materials that exhibits a threshold strength in which
the materials are strongly bonded together;
residual, compressive stresses exist in only one of the materials;
the material containing the compressive stresses stops cracks extending from the material that does not contain the compressive stress at an applied tensile stress less than the threshold strength;
each material has a different chemical composition relative to the other;
the material that contains the compressive stresses possesses the smallest volume fraction in the composite;
the material containing compressive stresses separates and exists between the material that does not contain compressive stresses;
the dimension of material that does not contain compressive stresses, measured perpendicular to the interface between the material that does contain the compressive stress and the material that does not contain the compressive stress, is smaller than 1000 microns;
the dimension of material that does contain compressive stresses, measured perpendicular to the interface between the material that does contain the compressive stresses and the material that does not contain the compressive stresses is between 1 times and 0.001 times the dimension of the material that does not contain the compressive stresses; and
the compressive stress is greater than 100 MPa.
2. (previously presented): A composite as in claim 1, in which layers of one material are separated by alternating layers of the other material; and in which all layers are bonded together; and in which one of the alternating materials contains biaxial, residual, compressive stresses; and in which, at applied tensile stresses less than a threshold value, cracks that extend from a layer that does not contain compressive stresses into the compressive layers are stopped and cannot cause catastrophic failure.
3. (canceled):
4. (canceled):
5. (original): A composite as in claims 1, 2, 3, or 4, in which the compressive stresses arise during cooling from a processing temperature to room temperature, caused by the differential strain induced by the differential thermal contraction coefficients of the different materials used to form the composite.

6. (previously presented): A composite as in claims 1, 2, 3, or 4, in which the compressive stresses arise during cooling from a processing temperature to room temperature, caused by a volume expansion of the material with the smallest volume fraction, in which the volume expansion is produced by a crystallographic phase transformation during cooling.

7. (previously presented): A composite as in claims 1, 2, 3, or 4, in which the compressive stresses arise by a chemical reaction that produces a volume increase during high temperature processing and this increase in volume is constrained by a material that does not take part in the reaction, and in which materials formed during processing with the increased molar volume will contain compressive stresses, whereas the material that does not take part in the chemical reaction, but constrains the molar increase, will not contain compressive stresses.

8. (previously presented): A composite as in claims 1, 2, 3, or 4, in which the compressive stresses arise by a chemical reaction that occurs during high temperature processing and this increase in molar volume is constrained by a material that does not take part in the reaction; and in which the materials that react together are silica (SiO_2) and alumina (Al_2O_3), which form mullite ($3 \text{ Al}_2\text{O}_3 : 2 \text{ SiO}_2$), the material placed in compression when constrained by the material that does not take part in the reaction.

9. (previously presented): A composite as in claims 1, 2, 3, or 4, in which the compressive stresses arise during cooling from a processing temperature to room temperature, caused by the differential strain induced by the differential thermal contraction coefficients of the different materials used to form the composite; and in which the material containing compressive stresses and the material that does not contain compressive stresses are each chosen from a list of materials that includes at least two materials that do not react together at the processing temperature needed to form a strong bond, but have differential thermal contraction coefficients such that compressive stresses would arise in one of the materials during cooling from a processing temperature.

10. (previously presented): A composite as in claims 1, 2, 3, or 4, in which the compressive stresses arise during cooling from a processing temperature to room temperature, caused by the differential strain induced by the differential thermal contraction coefficients of the different materials used to form the composite; and in which the material containing compressive stresses and the material that does not contain compressive stresses are each chosen from a list of materials that includes at least two materials that do not react together, but have differential thermal contraction coefficients such that compressive stresses would arise in one of the materials during cooling from a processing temperature; and in which the material that does not contain the compressive stresses does contain another material that would impart an additional property that affects threshold strength.

11. (previously presented): A composite as in claims 1, 2, 3, or 4, in which the compressive stresses arise during cooling from a processing temperature to room temperature, caused by the differential strain induced by the differential thermal contraction coefficients of the

different materials used to form the composite; and in which the material containing compressive stresses and the material that does not contain compressive stresses have differential thermal contraction coefficients such that compressive stresses will arise in one of the materials during cooling from a processing temperature; and in which the material that contains the compressive stresses also can contain another material that does impart an additional property important to mechanical strength and thus enhance the threshold strength and increase the crack growth resistance of the material containing the compressive stress.

12. (previously presented): A composite as in claims 1, 2, 3, or 4, in which the compressive stresses arise during cooling from a processing temperature to room temperature, caused by the differential strain induced by the differential thermal contraction coefficients of the materials used to form the composite; and in which at least one material is an amorphous material, without long range atomic order.

13. (previously presented): A composite as in claims 1, 2, 3, or 4, in which the compressive stresses arise during cooling from a processing temperature to room temperature, caused by the differential strain induced by the differential thermal contraction coefficients of the different materials used to form the composite; and in which at least one material is chosen from hydrocarbon polymers, where the polymer material has a lower thermal contraction coefficient relative to the material that does not contain compressive stresses, and where the material not containing compressive stresses is another polymer, and where either the polymer material containing the compressive stress or the polymer material not containing the compressive stress also contain another material that imparts an additional property important to mechanical strength and thus enhance the threshold strength and increase the crack growth resistance of the material containing the compressive stress.

14. (canceled)

15. (previously presented): A composite as in claims 1, 2, 3, or 4, in which the compressive stresses arise during cooling from a processing temperature to room temperature, caused by a volume expansion produced by a crystallographic phase transformation during cooling; and in which the material that exhibits a volume increase due to a structural phase transformation is zirconia with the tetragonal structure at high temperature, which transforms at a temperature below approximately 1100 °C to its monoclinic structure with a volume increase of approximately 3 %; and in which the other material is alumina or mullite which constrains the volume increase of the zirconia material and thus produce the desired compressive stresses in the transformed zirconia material.

16. (previously withdrawn): A method of processing the composites as in claims 1, 2, 3, or 4, using powder of the materials which are heated to a temperature where the materials are made dense by sintering.

17. (previously withdrawn): A method of processing the composite as in claims 1 or 2,

comprising the following steps: each of the materials is first formed as powder sheets; the sheets are then alternately stacked together and pressed together into contact; and then the sheets are heated to a temperature that would cause the densification of the materials.

18. (previously withdrawn): A method of processing the composite as in claims 1 or 3, comprising the following steps: one or more materials are first formed from a powder as cylindrical rods; the cylindrical rods are then coated with another material in which compressive stresses will arise during processing; the coated rods are pressed together to deform them into prismatic cylinders that are separated from each other by the coating material; and, after this pressing operation, the composite structure is then made dense by heating to a high temperature to induce sintering.

19. (previously withdrawn): A method of processing the composite as in claims 1 or 4, comprising the following steps: one or more materials are first formed from a powder as spheres; the spheres are then coated with another material in which the compressive stresses will arise during processing; the coated spheres are then pressed together to deform them into polyhedra that are separated by the coating material; and the powder composite is then heated to a temperature where the powders densify to form a dense composite material.

20. (previously withdrawn): A method of processing the composite as in claims 1 or 2, in which the materials are already dense materials that are stacked together and bonded together with an applied pressure.

21. (previously withdrawn): A method of processing the composite as in claims 1, 3, or 4, in which the materials that do not contain the compressive stresses are separately made with the described shape and then bonded together with the material that will contain the compressive stress.

22. (previously presented): A composite as in claim 8 in which the material that constrains the molar volume increase is alumina, and in which the volume fraction of the alumina is greater than the amount needed to form mullite when reacted with silica.

23. (currently amended): A composite as in claim 9 in which the material containing compressive stresses and the material that does not contain compressive stresses are each chosen from alumina, ~~zirconia~~, mullite, silicon nitride, silicon carbide, and titania.

24. (previously presented): A composite as in claim 10 in which the material containing compressive stresses and the material that does not contain compressive stresses are each chosen from alumina, zirconia, mullite, silicon nitride, silicon carbide, and titania.

25. (previously presented): A composite as in claim 10 in which the additional property affects threshold strength by controlling grain growth, changing the coefficient of thermal contraction, or changing the elastic modulus.

26. (previously presented): A composite as in claim 11 in which the material containing compressive stresses and the material that does not contain compressive stresses are each chosen from alumina, zirconia, mullite, silicon nitride, silicon carbide, and titania.

27. (previously presented): A composite as in claim 11 in which the additional property enhances threshold strength by controlling grain growth, changing the coefficient of thermal contraction, or changing the elastic modulus.

28. (previously presented): A composite as in claim 13 in which the additional property enhances threshold strength by controlling grain growth, changing the coefficient of thermal contraction, or changing the elastic modulus.

29. (new): A composite comprised of at least two materials that exhibits a threshold strength in which
the materials are strongly bonded together;
residual, compressive stresses exist in only one of the materials;
the material containing the compressive stresses stops cracks extending from the material that does not contain the compressive stress at an applied tensile stress less than the threshold strength;
each material has a different chemical composition relative to the other;
the material that contains the compressive stresses possesses the smallest volume fraction in the composite;
the material containing compressive stresses separates and exists between the material that does not contain compressive stresses;
the dimension of material that does not contain compressive stresses, measured perpendicular to the interface between the material that does contain the compressive stress and the material that does not contain the compressive stress, is smaller than 1000 microns;
the dimension of material that does contain compressive stresses, measured perpendicular to the interface between the material that does contain the compressive stresses and the material that does not contain the compressive stresses is between 1 times and 0.001 times the dimension of the material that does not contain the compressive stresses;
the compressive stress is greater than 100 MPa; and
prismatic cylinders of one material are separated and bonded to another material that contains residual compressive stresses, whereby at applied tensile stresses less than a threshold value, cracks that attempt to propagate from the prismatic cylinders into the material containing compressive stresses are stopped and cannot cause catastrophic failure.

30. (new): A composite comprised of at least two materials that exhibits a threshold strength in which
the materials are strongly bonded together;
residual, compressive stresses exist in only one of the materials;
the material containing the compressive stresses stops cracks extending from the material that does not contain the compressive stress at an applied tensile stress less than the threshold

strength;

- each material has a different chemical composition relative to the other;
- the material that contains the compressive stresses possesses the smallest volume fraction in the composite;

- the material containing compressive stresses separates and exists between the material that does not contain compressive stresses;

- the dimension of material that does not contain compressive stresses, measured perpendicular to the interface between the material that does contain the compressive stress and the material that does not contain the compressive stress, is smaller than 1000 microns;

- the dimension of material that does contain compressive stresses, measured perpendicular to the interface between the material that does contain the compressive stresses and the material that does not contain the compressive stresses is between 1 times and 0.001 times the dimension of the material that does not contain the compressive stresses;

- the compressive stress is greater than 100 MPa; and

- polyhedra of one material are separated and bonded to another material that contains residual compressive stresses, whereby at applied tensile stresses less than a threshold value, cracks that attempt to propagate from the polyhedra into the material containing compressive stresses that surround the polyhedra are stopped and cannot cause catastrophic failure.

31. (new): A composite comprised of at least two materials that exhibits a threshold strength in which

- the materials are strongly bonded together;

- residual, compressive stresses exist in only one of the materials;

- the material containing the compressive stresses stops cracks extending from the material that does not contain the compressive stress at an applied tensile stress less than the threshold strength;

- each material has a different chemical composition relative to the other;

- the material that contains the compressive stresses possesses the smallest volume fraction in the composite;

- the material containing compressive stresses separates and exists between the material that does not contain compressive stresses;

- the dimension of material that does not contain compressive stresses, measured perpendicular to the interface between the material that does contain the compressive stress and the material that does not contain the compressive stress, is smaller than 1000 microns;

- the dimension of material that does contain compressive stresses, measured perpendicular to the interface between the material that does contain the compressive stresses and the material that does not contain the compressive stresses is between 1 times and 0.001 times the dimension of the material that does not contain the compressive stresses;

- the compressive stress is greater than 100 MPa; and

- the compressive stresses arise during cooling from a processing temperature to room temperature, caused by the differential strain induced by the differential thermal contraction coefficients of the different materials used to form the composite, and in which the material containing compressive stresses and the material not containing compressive stresses are each a

metal, where one metal has a lower thermal contraction coefficient relative to the other metal.

32. (new): A composite comprised of at least two materials that exhibits a threshold strength in which

- the materials are strongly bonded together;
- residual, compressive stresses exist in only one of the materials;
- the material containing the compressive stresses stops cracks extending from the material that does not contain the compressive stress at an applied tensile stress less than the threshold strength;
- each material has a different chemical composition relative to the other;
- the material that contains the compressive stresses possesses the smallest volume fraction in the composite;
- the material containing compressive stresses separates and exists between the material that does not contain compressive stresses;
- the dimension of material that does not contain compressive stresses, measured perpendicular to the interface between the material that does contain the compressive stress and the material that does not contain the compressive stress, is smaller than 1000 microns;
- the dimension of material that does contain compressive stresses, measured perpendicular to the interface between the material that does contain the compressive stresses and the material that does not contain the compressive stresses is between 1 times and 0.001 times the dimension of the material that does not contain the compressive stresses;
- the compressive stress is greater than 100 MPa; and
- layers of one material are separated by alternating layers of the other material, all layers are bonded together; and one of the alternating materials contains biaxial, residual, compressive stresses, whereby at applied tensile stresses less than a threshold value, cracks that extend from a layer that does not contain compressive stresses into the compressive layers are stopped and cannot cause catastrophic failure; and
- the compressive stresses arise during cooling from a processing temperature to room temperature, caused by the differential strain induced by the differential thermal contraction coefficients of the different materials used to form the composite, the material containing compressive stresses and the material not containing compressive stresses being each a metal, where one metal has a lower thermal contraction coefficient relative to the other metal.

33. (new): A composite comprised of at least two materials that exhibits a threshold strength in which

- the materials are strongly bonded together;
- residual, compressive stresses exist in only one of the materials;
- the material containing the compressive stresses stops cracks extending from the material that does not contain the compressive stress at an applied tensile stress less than the threshold strength;
- each material has a different chemical composition relative to the other;
- the material that contains the compressive stresses possesses the smallest volume fraction in the composite;

the material containing compressive stresses separates and exists between the material that does not contain compressive stresses;

the dimension of material that does not contain compressive stresses, measured perpendicular to the interface between the material that does contain the compressive stress and the material that does not contain the compressive stress, is smaller than 1000 microns;

the dimension of material that does contain compressive stresses, measured perpendicular to the interface between the material that does contain the compressive stresses and the material that does not contain the compressive stresses is between 1 times and 0.001 times the dimension of the material that does not contain the compressive stresses;

the compressive stress is greater than 100 MPa;

prismatic cylinders of one material are separated and bonded to another material that contains residual compressive stresses, whereby at applied tensile stresses less than a threshold value, cracks that attempt to propagate from the prismatic cylinders into the material containing compressive stresses are stopped and cannot cause catastrophic failure; and

the compressive stresses arise during cooling from a processing temperature to room temperature, caused by the differential strain induced by the differential thermal contraction coefficients of the different materials used to form the composite, the material containing compressive stresses and the material not containing compressive stresses being each a metal, where one metal has a lower thermal contraction coefficient relative to the other metal.

34. (new): A composite comprised of at least two materials that exhibits a threshold strength in which

the materials are strongly bonded together;

residual, compressive stresses exist in only one of the materials;

the material containing the compressive stresses stops cracks extending from the material that does not contain the compressive stress at an applied tensile stress less than the threshold strength;

each material has a different chemical composition relative to the other;

the material that contains the compressive stresses possesses the smallest volume fraction in the composite;

the material containing compressive stresses separates and exists between the material that does not contain compressive stresses;

the dimension of material that does not contain compressive stresses, measured perpendicular to the interface between the material that does contain the compressive stress and the material that does not contain the compressive stress, is smaller than 1000 microns;

the dimension of material that does contain compressive stresses, measured perpendicular to the interface between the material that does contain the compressive stresses and the material that does not contain the compressive stresses is between 1 times and 0.001 times the dimension of the material that does not contain the compressive stresses;

the compressive stress is greater than 100 MPa; and

a polyhedra of one material are separated and bonded to another material that contains residual compressive stresses, whereby at applied tensile stresses less than a threshold value, cracks that attempt to propagate from the polyhedra into the material containing compressive

Appl. No. 09/670,918
Amdt. dated April 19, 2004
Reply to Office Action of December 29, 2004

stresses that surround the polyhedra are stopped and cannot cause catastrophic failure; and the compressive stresses arise during cooling from a processing temperature to room temperature, caused by the differential strain induced by the differential thermal contraction coefficients of the different materials used to form the composite, the material containing compressive stresses and the material not containing compressive stresses being each a metal, where one metal has a lower thermal contraction coefficient relative to the other metal.